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ABSTRACT

This book is designed to involve families working together on several different hands-on activities during evening meetings at school. The basis for these activities is the in-school study of related science and mathematical concepts and topics by the students in each family. The program provides an opportunity for families to work together in an interesting and enjoyable manner. The Family Aeronautical Science demonstration project consisted of three parts: (1) the in-school study of aeronautics during select science classes; (2) the extensive after-school use of the school's computer laboratory; and (3) evening Family Aeronautical Science Nights. Key parts of the in-class work included the study of basic aerodynamics, flight control systems, wing design, and basic flight maneuvers. The educational paradigm was that students and teachers would cover several appropriate parts of the study at school and the students would continue study after school hours with family members in the computer labs using an aeronautics CD. (KHR)

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THE UNO AVIATION MONOGRAPH SERIES

UNOAI Report 02-6

The Family Science Starter Kit: A Manual to Assist You in the Development of a Family Aeronautical Science Program

Dr. Henry R. Lehrer

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Dr. Henry R. Lehrer

November 2002

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The Family Science Starter Kit:

A Manual to Assist You in the Development of a Family Aeronautical Science Program

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Family Science Background

Family science is a program designed to involve families working together on several different hands-on activities during evening meetings at school. The basis for these activities is the in-school study of related science and mathematics concepts and topics by the students in each family. Sometimes special demonstrations and guest speakers are included in the programs. Also, ideas are given to parents on how to conduct possible experiments and projects at home with their children. These activities can be done using materials readily available in most homes or supplied by the school. Hopefully, as a result of the Family Science programs, parents and students will realize that science can be fun.

The purpose of the program is not to make parents into scientists or their child's primary teacher, but to provide an opportunity for families to work together in an interesting and enjoyable manner. Of course, by engaging in such activities, it will become more apparent that science is not only for school, but that it is related to the real, everyday lives of everyone. Needless to say, doing such activities provides additional time for the learning of science and mathematics as well as enhancing a student's learning skills.

A Demonstration Project

A Family Aeronautical Science demonstration project was launched during the 2000-2001 school year at the Santee Community Schools in Niobrara, Nebraska. The initial target group for the project was upper elementary children approximately 11- 12 years of age in the school or those found in grades 4 to 6. The demonstration involved the parents and extended families of those children; faculty and staff of the school and the Nebraska Indian Community College; and faculty researchers of the NASA Nebraska Space Grant Consortium (NSGC) and the University of Nebraska at Omaha (UNO).

The demonstration project consisted of three distinct parts, the in-school study of aeronautics during select science classes, the extensive, after-school use of the school's computer laboratory, and evening Family Aeronautical Science Nights. Key parts of the in-class work were the study of basic aerodynamics, flight control systems, wing design, and basic flight maneuvers. The educational paradigm was that students and teachers would cover several appropriate parts of the study unit at school, the students would continue study after school hours with the family members in the computer lab using an aeronautics CD, and there would be bi-monthly Family Aeronautical Science Nights at the school.

The science night included an evening meal plus a combination of chemistry and physics demonstrations by university faculty members, directed group activities, visits by researchers/educators, and fellowship. The drawing for door prizes was a much anticipated part of each night's events. There were a total of four Family Aeronautical Science Nights scheduled during the demonstration phase of the project.

The dates, projects, and the attendance for the demonstration project are outlined below.

Date	Event	# of Participants
October 2000	Aero Games	47
November 2000	CAPOW Wagon	137
February 2001	Heavy Snow – Event Cancelled	
April 2001	Flight Simulator	48

During the October 2000 Family Aeronautical Science Night, the initial meeting, participants became acquainted with the concept of a parent-student activity and engaged in flight-related games that used balsa wood airplanes or paper gliders. The second meeting was a demonstration by the Chemistry and Physics on Wheels (CAPOW) Wagon, a science demonstration presented by professors from the UNO. Due to the wide appeal of such this event, students and families in grades 7 -12 were also invited. The third scheduled meeting was cancelled due to snow but the final science night of the year was the demonstration of a desktop flight simulator and its use to the parents; the students acted as the coach for their team members. Most parents were able to perform basic flight maneuvers by the end of the evening.

The use of aeronautics and space related subjects for the project was not accidental but rather an intentional focus on youngsters' fascination with airplanes and rockets. Such subject matter has been found time and time again to capture the imagination of not only school age children but their parents as well. The field of aeronautics is full of practical applications related to some of the most exciting things about airplanes and rockets. Since the underlying goal of this whole initiative is the continued improvement of mathematics and science, we sought to capitalize on this fascination.

This endeavor will, in the long term, focus on systemic change for a school network through the implementation of Family Aeronautical Science. Programs are currently being exported to other schools as well. Specifically, Family Aeronautical Science projects are being duplicated with students in the Winnebago and Walthill, Nebraska school districts. It is hoped that a state-wide educational change in using value-added programs like Family Aeronautical Science will provide students and their parents with a new common-ground of exciting family related activities resulting from this trailblazing initiative.

The benefits of involving parents in education are not confined solely to the early school years such as those involved in this effort. Research has shown that significant gains at all ages and grade levels can be achieved when parents share in their children's education. Junior high and high school students whose parents remain involved make better transitions, maintain the quality of their work, and develop more realistic plans for their future. Children from diverse cultural backgrounds tend to do better when parents and professionals collaborate to bridge the gap between the culture at home and the learning institution.

Structure of the Starter Kit

There are two parts to the Starter Kit, the use of the Exploring Aeronautics CD and the Family Aeronautical Science Activities Outlines. A detailed description of each follows.

Exploring Aeronautics CD

The Exploring Aeronautics CD is the reference source that teachers should use to develop their own specific study of the aeronautics fields contained on the CD. While it is possible to utilize the CD solely in a visual format, it may be best if certain sections or even one complete reference source be printed for each school building. Exactly how and in what order the material contained on the CD is used should be at the discretion of each teacher. However, following the suggested lesson planner contained in Part 1 of the outline of the introductory units may provide the most logical and comprehensive initial methodology.

Contained within the reference source are lesson plans, student assignments, teacher reading sections, and inter-disciplinary instructional units (art, music, science, mathematics, social studies, oral language, and physical education). All units are based on aeronautical subject matter and the focus is on grades 5 -8. The CD also contains many visual study units that students can view at a computer. Each unit is a well-designed and imaginative lesson that is integrated with the outline and sequence of the reference source. The teacher may use these visual sections as part of the classroom instructional activities or as supplemental units.

Family Aeronautical Science Activities Outlines

An integral part of the Family Aeronautical Science program is the bringing together of students, their parents, as well as other members of the family. These meetings should be scheduled on a school night and should begin from 5 to 6 p.m. depending on the school's availability and the organizer's preference. It has been found that these family nights should occur during approximately the 2nd, 4th, 6th, and final month of the school academic year. This sequence of scheduling allows the classroom instruction to begin before a concept is encountered during the evening activity. Most of the activities can be easily staged in a school gymnasium or field house, a community activity center, or a church or synagogue fellowship hall.

The inclusion of an evening meal or light snack, either before or after the activity, is an extremely important part of the event. Most school cafeterias and lunchrooms make ideal locations for preparing and serving food. When the meal precedes the evening's activity, there is a longer period of time for families to arrive at the school and then activities can begin with the majority of participants present. However, in the case of events that need to be scheduled for school athletic fields or in stadiums due to the nature of the activity or to make best use of daylight, the option of having the meal, snack, or light refreshments as a concluding event should be considered. Above all, the serving of food has a unifying purpose for the Family Aeronautical Science Night and should be viewed as an important fellowship-building event. One hour has been found to be about the ideal length for this portion of the evening.

The following are items that have been found to be extremely important in staging a Family Aeronautical Science Night.

- It is important that you read the entire manual before beginning the first activity. You need to have an understanding of how the entire program is integrated and formatted.
- Co-operation and co-ordination by the school administration, faculty, and staff at the earliest possible time is critical to success of the event.
- Send an invitation to the parents asking them to attend the science night home with students at least 2 weeks prior to the event. Request an RSVP.
- Plan for a 2 hour event, one hour for the meal/snack and one hour for the activity.
- Designate one key faculty member as the local coordinator. This individual will be the main point of contact for the event and will be responsible for coordinating all activities associated with the program.
- Have as many administrators and faculty/staff members attend each Family Aeronautical Science Night as possible. Not only is their presence needed to show support for the events but these individuals can be used a group leaders or event assistants. You can never have too many principals present.
- The optimum number of attendees for the activity-based events is from 45 to 70. For demonstration-only science nights, a larger group can be accommodated using bleacher or similar seating.
- Have a sign-in station for all attendees; designate a teacher that knows many of the children to be in charge of this activity. Require that each child has an adult parent or guardian with them.
- Recruit older students to be event assistants. The development of role models is important.
- Include a door prize drawing of some sort at each event. You may wish to ask local businesses or sponsors to provide either donations or financial support for these prizes. If so, give your sponsors a great deal of visibility.
- Inform the local press about the event and request coverage.
- Completely record the events in the series with pictures of all events and activities.
- Ask a local minister, rabbi, or tribal elder to begin the evening meal with a blessing.
- Invite science and mathematics teachers and administrators from neighboring school to attend and encourage their participation in some way with the evening's activities.

Each of the Family Aeronautical Science units that are included in the following pages outline the specific manner in which to stage each activity. While these have been found to be effective, each of them can be organized in any number of other ways. The final decision regarding the exact structure of the Family Aeronautical Science Night should rest with each school.

Use of the Exploring Aeronautics CD

The Exploring Aeronautics CD is an integral part of the Family Aeronautical Science program. The CD contains includes activities and actual videos focused on How Airplanes Fly, the Tools of Aeronautics, Different Wing Designs, and student and teacher materials. A 600-page teacher's manual in .pdf is included as well as many animated sections. Everything needed to get started is on this one CD. The CD is available from NASA CORE: http://core.nasa.gov or (440) 774-1051. The following is a brief overview of what is contained on the CD:

Section 1 Introduction (99 pages)

- Pedagogical Basis
- Using the Instructional Unit
- Assessment

Section 2 Contents (182 pages)

- Introduction to Aeronautics
- The Scientific Method
- Four Forces of Aeronautics
- Wings
- Airplane Control
- Tools of Aeronautics

Section 3 Appendices (113 pages)

- Aeronautics Glossary
- Resources and References

Curriculum Goals and Objectives

The following goals and objectives are contained in the Exploring Aeronautics CD. Each goal is related to a major skills/ability that should be the focus of the unit. Each objective is anchored with an action verb and a measurable result.

Goal I: To use the Scientific Method to answer a question or solve a problem.

The Learner will be able to:

- recite the steps of the scientific method.
- develop each part of the scientific method.
- identify a question.
- identify a hypothesis.
- construct an experiment.
- list procedures which will complete the experiment.
- list material needed to perform the experiment.
- perform experiment.
- observe and record results.
- write a conclusion.
- identify a new question generated by the experiment.

Goal 2: To understand that the progression of the science of aeronautics was influenced by the technology of the time and historic events, as well as individuals, agencies and groups who worked to solve problems.

The Learner will be able to:

- gather information from a variety of resources (handouts, CD-ROM programs, encyclopedia, Internet, library print material and timelines).
- identify important aspects of aeronautical history with respect to five specified categories.
- chronicle important events, discoveries and innovations in aeronautics using a timeline format.

Goal 3: To understand that there are a variety of aircraft types which have been designed for specific purposes.

The Learner will be able to:

- identify and describe the basic categories of aircraft.
- identify features of an aircraft and then categorize that aircraft based upon those features.
- identify and describe the regimes in which aircraft fly.
- compare aircraft based upon their characteristics.
- compare aircraft types based upon their regime.
- define the speed of sound.
- describe the phenomenon of flight.
- identify and describe how sound travels in waves.

Goal 4: To understand the four forces and their effect on aircraft.

The Learner will be able to:

- name and define each of the four forces that influence flight.
- describe the effect of each of the four forces upon an aircraft.
- identify how the four forces work in an oppositional manner.
- define a force.

Goal 5: To understand the relationship between the shape of an airfoil and the four forces.

The Learner will be able to:

- draw and label an airfoil and indicate airflow.
- describe how air pressure is affected by airflow.
- describe how air pressure influences lift.

Goal 6: To understand the control surfaces and motions of an airplane.

The Learner will be able to:

- identify and demonstrate the six motions of an airplane.
- identify the three axes that help to define the motions of an airplane.
- identify and label the control surfaces of an airplane.
- demonstrate the movement which occurs as each control surface is manipulated, both individually and together.

Goal 7: To understand what tools engineers and scientists use to test aircraft designs and how these tools are employed.

The Learner will be able to:

- list the four tools of aeronautics.
- describe how each tool works.
- identify the importance of testing aircraft with these tools.
- contrast modern tools to early tools.
- discuss the importance of each tool to aircraft design.

Goal 8: To understand how aeronautics has become an integral part of our modern world.

The Learner will be able to:

- identify the varied uses of aircraft in our society.
- identify occupations associated with aeronautics.
- describe new aircraft designs being considered for future development.

Organization of the Family Aeronautical Science Units

The following is a two academic-year outline of how to schedule the specific activities that will make up each Family Aeronautical Science Night. As previous mentioned, there are 4 activities per year with approximately 6 to 8 weeks between each activity. You have complete discretion as to when to schedule these events but the guidelines previously outlined have proven to be an effective model.

Year 1

- Event 1: Introductory Family Aeronautical Science Night: Construction of and Flight Maneuvers with Balsawood Airplane and/or Paper Gliders
- Event 2: Chemistry and Physics Demonstration Show
- Event 3: Building and Launching The Alka-Seltzer Rocket
- Event 4: A Locally Developed Family Aeronautical Science Unit

Year 2

- Event 1: Building the Delta Dart Rubber-band Airplane
- Event 2: Flight Competition with the Delta Dart
- Event 3: Preliminary Construction of the Estes Gnome Rocket
- Event 4: Fueling and Launching the Estes Rocket

The following of rigid safety precautions for all events, particularly the flight and launch events, can not be stressed enough. Each event should begin with an overview of the particular dangers associated with activities required that night. In addition, the use of sharp knives and pins is required in the construction of airplanes or rockets; it is imperative that parents/guardians take sole responsibility for the utilization of these pieces of equipment. Nothing could mar an evening's activity like a participant being injured; there is a need to be cautious and careful.

Family Aeronautical Science Activity Outline: Year 1 Event 1

Aeronautics Introductory Night

Description of the Activity: This is the initial family activity in the Family Aeronautical Science program and serves an introduction to the program and to what will be standard operating procedure. A major focus of this event is having the participants become acquainted with one another; the need to develop strong fellowship within the group can not be stressed enough.

Goal and Objectives:

- To develop a sense of community within the group and begin to view the family unit as a productive entity.
- To experience, through family-focused activity, a sense of increased unity.
- To learn the procedures for conducting this and all future events.
- To engage in primary aeronautical activity through the construction and flying of paper gliders and/or balsa wood airplane.

Length of Event: This should be a two-hour event. One hour is devoted to the group meal/snack and the rest of the time to the aeronautical activity. As with all events in the series, the activity may precede the meal or vice versa depending on the specific requirements of the event.

Equipment Needed:

- Several rolls of masking tape and a marker.
- A hula-hoop.
- A sufficient number of balsawood airplanes and/or materials to construct paper airplanes/gliders.
- A scorecard for participants to record their scores (this will be covered later).
- Tables and chairs for seating.
- A length of heavy twine.
- A tape measure.

Task and Descriptions: It is strongly suggested that the gymnasium or place where the event will occur is prepared before the starting time. Refer to Appendix A for a diagram of how to mark the floor with tape to denote the three parts of the layout. Designate each of the three stations as follows:

- Station 1 – Flight Distance: Run a stripe of masking tape to mark the floor. Start at the closest out-of-bounds and place the tape on the floor and run a straight tape-line to the furthest out-of-bounds. Mark the tape at 5 foot intervals with a marker so that the distance of flight can be determined.
- Station 2 – Landing: Approximately 15 feet from the far out-of bounds, make a rectangular box, simulating an airport runway, on the floor. The "runway" should be a minimum of 4 feet in width and 18 feet in length. Use additional tape to simulate a dashed runway centerline. Also divide the runway into thirds.

- Station 3 – Precision Flight: Using masking tape, hang a hula-hoop from the rim of the basketball hoop so that the bottom of the hula is from 3 to 4 feet above the floor. Secure the hula-hoop to the floor by running tape from the 5 o'clock and 7 o'clock positions as you face the hoop. You should have the hoop secured now in a Y shape.
- Additional area – You may wish to have a flight test area where participants can do short test flights to "get the feel" of launching their airplanes and/or gliders. You need to supervise this area very closely so that participants are not launching aircraft in a haphazard or unsafe manner.

Object of the Games: Each of the stations has a specific objective in how it is to be used. The stations should be thought of as separate games with a combined score for each family's performance at the various segments totaled in some way; you will need to develop some sort of point award for each station. The highest total scores should be recognized and some sort of prize, preferably aeronautics-related, awarded. Develop a scorecard so that participants can tally their scores. The object for each station is as follows:

- Station 1: While total distance is important, straight flight is sought. When a participant launches their aircraft, the total distance is the downrange distance minus the distance off the centerline. Use a piece of twine to measure the lateral displacement from the centerline and then deduct that amount from the length of flight.
- Station 2: Landing in the 1st third of the runway is the main object of the station. The highest number of points should be awarded for the 1st third and a lesser amount for distance past that point. You can experiment with the launch site for this station and adjust that point for various age participants (closer for very young children, further away for adults, etc.).
- Station 3: Using the foul shot line as a launch point (and adjusting as you see fit for various types of aircraft or differing skill levels of the participants), the object is to fly the plane or glider though the hula-hoop.

Additional Notes: The following are a few additional considerations and ideas for this and other family aeronautical science events.

- Have as many administrators, teachers, and other staff members in attendance as possible. Use these individuals as station leaders or helpers. The more assistance that these individuals can give to participants, the more successful the event.
- Divide participants into 3 or 4 groups. Start each group at a station with one in reserve, waiting in the bleachers, or use three groups and rotate. It is best to rotate on command.
- You may decide to give each participant a practice try at each station or rotate groups though the various stations several times.
- Keep extensive attendance records.
- There are numerous paper glider designs on the internet or on the Exploring Aeronautics CD.
- For large family groups, you may wish to have several planes or rockets for each family. As with all the activities in this series, it is important that all members of a unit are active participants.

Family Aeronautical Science Activity Outline: Year 1 Event 2

Chemistry and Physics Demonstration

Description of the Activity: This activity is an event that should be staged by a local college or university or if not available, a team of high school science teachers. Many academic science departments have such a demonstration team; that team visits local schools and performs exciting science demonstrations. At the University of Nebraska at Omaha, this activity is called the CAPOW (Chemistry and Physics on Wheels) Wagon. Staffed by senior faculty members in the chemistry and physics department at UNO, the CAPOW Wagon travels to schools and demonstrates the marvels of the sciences to audiences of all ages.

Goal and Objectives:

- To continue to develop the sense of community with the group.
- To demonstrate the marvels of science and physics.
- To learn to relate the field of science, mathematics, and physic to aeronautics.

Length of Event: This should be a two-hour event. One hour is devoted to the group meal/snack and the rest of the time to the demonstration activity. As with all events in the series, the activity may precede the meal or vice versa depending on the specific requirements of the event.

Equipment Needed: The demonstration team will usually have all their equipment but it will be necessary to have several tables available. These tables can be placed on the gymnasium floor in front of the center section of bleachers. It will be important that attendees are made aware that often, dangerous chemical may be used in demonstrations. At no time should any of the equipment or materials be touched by anyone other than the demonstration team.

Task and Descriptions:

- The demonstration team will need to set up their equipment and materials at least 30 minutes prior to the event and the area will need to be secured.
- Take attendance as outlined in the previous events.
- Have as many administrators present as possible and ask that the demonstrators use these individuals as "assistants" some of the demonstrations: have the team use students as "helpers" as much as possible.
- If a college or university demonstration team is not available, using local science teachers can have very satisfactory results. Not only can you build the status of these teachers within the school community but it is beneficial to showcase a student's future teachers in such a role. Science suddenly becomes less mysterious and more appealing.

Family Aeronautical Science Activity Outline: Year 1 Event 3

Alka-Seltzer Rocket

Description of the Activity: This session in the Family Aeronautical Science series will center on the construction and the launching of a paper rocker that is made from common household items. The first part of the event will be the construction of the rocket and the second half will be the fueling and launching.

Goal and Objectives:

- To continue to develop the sense of community with the group.
- To demonstrate practical applications of science principles. In this case, the law of action and reaction is being demonstrated.
- To provide a catalyst that combines units of science with the developments in space.
- To create a preliminary interest in students to pursue careers in space-related fields.

Length of Event: The regular format that you have developed during the previous two events is what you should be using for this event. However, feel free to modify the schedule depending on unique local situations. The final portion, fueling and blast-off, can be conducted either indoors or on an athletic field or other outdoor location.

Equipment Needed: All of the equipment needed for this activity is readily available and costs very little. A bit of pre-planning will be needed to secure an adequate supply of the correct type of film canisters for the event. Contact a local one-hour film processing business and ask them to save a numbers of canisters for you; note the description below with respect to this requirement.

- Paper, regular 8 ½ by 11 size.
- Plastic 35mm plastic film canisters (you want to try to use only the film canisters that have a cap on the inside of the canister rather than on the outside).
- Rolls of cellophane tape.
- Several boxes of crayons or colored pencils (for decorating the rockets)
- Several pair of scissors.
- Effervescing (fizzing) antacid tablets (the kind you'd use for an upset stomach)
- Some small paper cups.
- Paper towels.
- Water.

Task and Descriptions: Assembling the rocket is very simple and requires a little bit of cutting and taping for assembly. Use the template in Appendix II or use any similar pattern that is available on the internet; there is no right or wrong way to do this as long as you have the basic parts: body, fins, and nose cone. Duplicate a sufficient number of template pages so that each family has at least one (for large family groups, you will need more than one).

Assembly

- Cut the rocket from the template. Feel free to modify the body of the rocket: you can make it short and fat, or long and skinny. There is no wrong way to do this.
- Cut out the nose cone and the fins.
- Color the body of the rocket as you desire. You may want to have a judging for the most creative design.
- Tape the film canister to the body (with the open end out) and roll the paper around the film can; secure with tape. You may wish to initially tape the body of the film canister to the body.
- Mount the fins and the nose cone to the body of the rocket.

Fueling and Blast-off

- Crumble ½ of an antacid tablet into very small pieces.
- Turn the rocket upside down so that you are looking into the film canister and pour the crumbled tablet into the canister.
- Fill the canister about 1/3 full of water.
- Snap the lip into place.
- Stand the rocket on the gymnasium floor, a sidewalk or driveway, or in a field.
- Stand back and wait and the rocket will blast off.

Family Aeronautical Science Activity Outline: Year 1 Event 4

Local School Activity Selection

Description of the Activity: This activity is the final event in the first year of the Family Aeronautical Science program. The selection of the specific activity is at the option of the team that is providing local leadership (an elementary school faculty unit, a team of school science teachers, or another similar group).

Goal and Objectives: The primary objective of this unit is to give the local education unit an opportunity to plan and carry out an event that is of interest to that school's faculty and administration, students, and parents that attend.

Length of Event: Use the standard format for the event that you have become accustomed to utilizing.

Equipment Needed: The equipment required will depend on the activity selected. However, the utilization of readily accessible materials is a hallmark of the program. Try to keep costs reasonable.

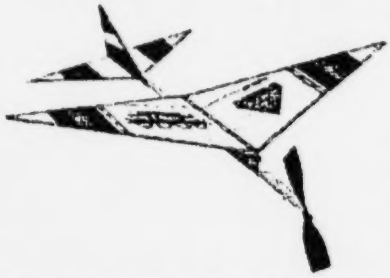
Task and Descriptions: Some possible examples of events that can be staged using the Exploring Aeronautics CD and associated materials include such activities as:

- A group test of aeronautical knowledge using board games, crossword puzzles, etc as the testing device.
- An aeronautical careers night when selected aviation professional explain the specifics of their vocation. This is an excellent time to ask for assistance from any local military aviation groups like the US Air Force, Air Guard, or Naval Aviation. Additionally, airline and commercial pilots are rich sources of information.
- A creative events session that includes faculty members from the school's English Department. Participants can write poems or short stories on aviation.
- Constructing a simple kite from balsa wood stick, newspaper, and string. Fly them at the conclusion.
- Mathematics Night. Playing many of the mathematics games that are contained on the Exploring Aeronautics CD or from those found at the www.nasaexplores.com website.
- Have an aviation film festival using many of the excellent videotapes that are available free from the local Federal Aviation Administration (FAA) Flight Standards District Office or NASA Teacher Resource Center.
- Set up several computers in the school's lab as flight simulators. Participants can learn to fly the simulator in a very short period of time.
- Conduct one of the excellent activities found at www.nasaexplores.com or one of the other NASA education websites.

Family Aeronautical Science Activity Outline: Year 2 Event 1

Delta Dart I

Description of the Activity: This little plane is a balsa wood and paper aircraft that has been the flagship for model aviation for over thirty years; millions have been built around the world. Perfectly suited to indoor conditions, the Delta Dart can be built with very little help by most upper elementary, middle, and secondary students. The airplane kits are very inexpensive and most construction and flight can be completed in a multi-purpose room or gymnasium.



Goal and Objectives: The construction and flying of a Delta Dart will give students and parents the opportunity to:

- Learn physical science and science process skills.
- Make abstract aeronautical concepts more understandable.
- Provide concrete, real-life applications in forces, center of gravity, mathematics, and experimentation.

Length of Event: This event may require more time to complete the preliminary construction of the Delta Dart. Since the building process must go through the first 17 steps in the initial meeting before the construction reaches a point where the model's glue must dry, it might be appropriate to allow extra time for this session.

Equipment Needed: Delta Dart kits are available in bulk pack of 40 units for $30.95 (item # 6093). These kits can be ordered from the Academy of Model Aeronautics (AMA) as the AMA Cub (Delta Dart) Youth Program Bulk Pack. The web address for AMA is http://modelaircraft.org/ and search for the Delta Dart. The following specific equipment is needed:

- Sheets of cardboard that have been cut to the dimensions of the Delta Dart plan. You will need to have one for each airplane that is being built.
- Several tubes of airplane glue.
- Straight pins and/or masking tape.
- Single-edge razor blades or Exacto knives **(Caution: only adults should be allowed to handle the razor blade or knife)**.
- A package of long rubber bands.

Task and Descriptions: The directions for building the Delta Dart are clear and easy to

understand. It is suggested that the leadership team build and flight test several of the airplanes prior to the event. Organization of the building might use the following steps:

- Give each participating family group an airplane kit. Have the kits opened and identify all the parts that are contained in the kit.
- Read through the directions as a group answering any questions that participants might have concerning specific steps.
- Pass out the building supplies and have each group do the first 4 steps and then stop and check each team's progress so far.
- Steps 5 and 6 are the first critical cutting and gluing tasks and these should be done together before proceeding further.
- Once participants have successfully complete Step 6, you may have the groups proceed to complete Steps 7 through 11. Stop there and determine that all participants have been successful.
- Complete Steps 12 and 13 and check all tails and wings for quality of construction; repair any faulty glue seams or joints.
- Continue through Step 18 and stop. At this point, you have reached a place where the construction process can be discontinued for a length of time. Make sure each group has written the family name on the cardboard.
- You can have the group take the partially completed model home but it is probably best to store the airplanes at the school until the next event.

Family Aeronautical Science Activity Outline: Year 2 Event 2

Delta Dart II

Description of the Activity: This session of Family Aeronautical Science will complete the construction of the Delta Dart and begin the flight testing of the airplane.

Goal and Objectives: During this unit, participants will:

- Complete the construction of the Delta Dart model airplane.
- Continue to learn physical science and science process skills.
- Experience actual flight test applications that will involve the 4 aeronautical forces, center of gravity computations, applied mathematics, and flight regime experimentation.

Length of Event: This event should be of normal two-hour length with the first consisting of the meal/snack and the last portion the completion of the airplane and then flight testing.

Equipment Needed: You may wish to have the same materials as used in the previous session available for any repairs that might need to be made and for the completion of the project. However, if no remedial work is required, the only equipment need for this session is:

- Bag of rubber bands.
- Some modeling clay or putty. This will be used to correct any out-of-balance flight conditions.

Task and Descriptions: It might be appropriate to review what was accomplished in the previous session. If there are participants that did not build the Delta Dart in the previous session, you may wish to have a small "special group" for those families; assign an experienced leader to this group and complete as many of Steps 1 through 18 as possible. However, for the participants that are ready to proceed beyond Step 19:

- Remove the model as shown in step 20.
- Complete Steps 21 to 24 and stop. You are ready to go to the Flight Test Area (the gymnasium or outdoors if the wind and weather permit.

Flight Testing

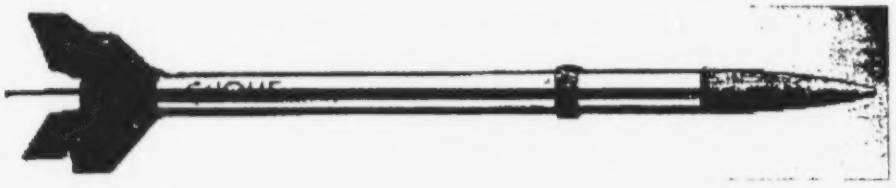
- Steps 25 to 30 are those that allow each airplane to be adjusted for best performance. Issues encountered at this stage will be questions of weight & balance of the airframe, angle of propeller thrust, as well as other flight mechanics problems.
- The use of small amounts of putty or clay on various control surfaces can influence the flight of the airplane. Participants should experiment with what is necessary to achieve turning flight (both right and left), straight & level flight, climbs, and descents. These are the four primary flight maneuvers that all pilots learn in their first few flight lessons.

- You may wish to use the setup for the gymnasium that is contained in Appendix I and used for the Introductory Family Aeronautical Science Event. However, the primary emphasis should be on Station 1: Flight Distance and Station 2 Landing Accuracy.
- You may wish to add a Duration of Flight Category but this may be difficult to complete unless out-of-doors. Measure the time from launch until landing.

Family Aeronautical Science Activity Outline: Year 2 Event 3

Estes Rocket I

Description of the Activity: The activity for this Family Aeronautical Science event will be the construction of the Estes Gnome Rocket. The Gnome is a precision engineered kit that requires little assembly to prepare it to fly. The rocket is capable of reaching altitudes up to 800 feet (246 meters), depending on the engine you select. The assembly is quick, no painting is required, and the kit described below comes with detailed illustrated assembly and launch instructions.



Goal and Objectives: There are many unique qualities associated with this culminating event in the 2 year Family Aeronautical Science series. Participants will have an opportunity to:

- Play an active role in all phases of rocket construction, launch and experiment development.
- Improve the co-operative skills in a group activity.
- Develop a greater attention to details of construction.
- Experience an affordable "technology in miniature" that will acquaint all with technical terms, concepts, and issues that relate to model rocketry.
- Realize that the importance of mathematics and science as important school academic subjects can not be minimized.

Length of Event: Use the standard format for the event that you have become accustomed to utilizing.

Equipment Needed: Purchasing the rocket kit for the Estes Gnome Rocket can be done on-line or by phone. A source for bulk kits is http://www.acsupplyco.com/estes/gnome.htm which offers kits at a price for the EST1750 12-piece pack (MSRP of $47.79) for $32.02. However, be sure to check the internet for other sources. Just about all the materials that are required come with the rocket kit. For this event, you'll need:

- Plastic Glue.
- A sufficient number of kits for the participants.

Task and Descriptions: Assembly of the rocket is easy and should take approximately one hour. The instructions that come with the kit are easy to follow and there is no painting

required. A few of the highlights of the activity follow.

- The assembly of the chrome cardboard body tube with the one-piece blue plastic fin unit and nose cone are the major task.
- It may be best to have the entire group assemble the rocket one step at a time since there are not too many individual steps.
- Since the rocket kit is a bit more expensive that the Delta Dart, you may want to limit the numbers of Gnome Rockets used to one per family. All members can have a part in the construction and launch.
- Be sure to mount the neon orange streamer; this streamer will assist in recovery.
- It is not too soon to review the safety issues involved in the launching of the rockets during the next activity.
- It might be helpful to have one of the leadership team give a short overview on the development of rockets from the earliest Chinese devices to the current population units used on the space shuttle.
- Upon completion of the assembly, it may be best to keep the rockets at the school until the next scheduled event.
- At the next event, participants will fuel and launch their rockets.

Family Aeronautical Science Activity Outline: Year 2 Event 4

Estes Rocket II

Description of the Activity: This is the final activity in the entire two-year Family Aeronautical Science program and will deal with the fueling and launching of the Estes Gnome Rocket. This event is by far the most exciting.

Goal and Objectives:

- To launch and recover the Estes Gnome Rocket.
- To gain an insight into the field of model rocketry.
- To use the group process to complete an aeronautical problem.

Length of Event: Use the standard format for the event that you have become accustomed to utilizing.

Equipment Needed: It will be necessary to obtain the fuel cells and rocket launching equipment from the source used for the rocket kits. The type fuel cells used will determine how high the rocket will soar. The smallest and the least expensive engine bulk pack which includes 24 engines, 30 ignitors & ignitor plugs, and 1pack of wadding is the 1/2A3-2T for approximately $27.00. You can order the required launch equipment from the same or a similar supplier. However, you will need the following:

- A box of facial tissues to use in the body of the rocket as wadding between the engine and the tube assembly.
- A sufficient number of rocket engines and ignitors for at least one launch per family. These are one-time use items. Order more if the budget allows and allow a second launch if possible.
- Launch stands and ignition panels; batteries for the ignition panels.
- Ropes and stakes to designate the outdoor launch area. Traffic safety cones can also be used.

Task and Descriptions: There are two distinct activities for this event: the completion of the rocket construction portion of the event with the fueling of the rocket and the launch of the completed assembly.

Fueling

- Pass out the rockets that were assembled during the previous activity period. Make any minor repairs that are required.
- Insert recovery wadding (refer to the directions for the correct amount) into the rocket body.
- Fold and insert the recovery streamer into the top of the body tube and insert the nose plug.
- It is important to correctly complete the following fuel steps; you may wish to do these step by step with the entire group.

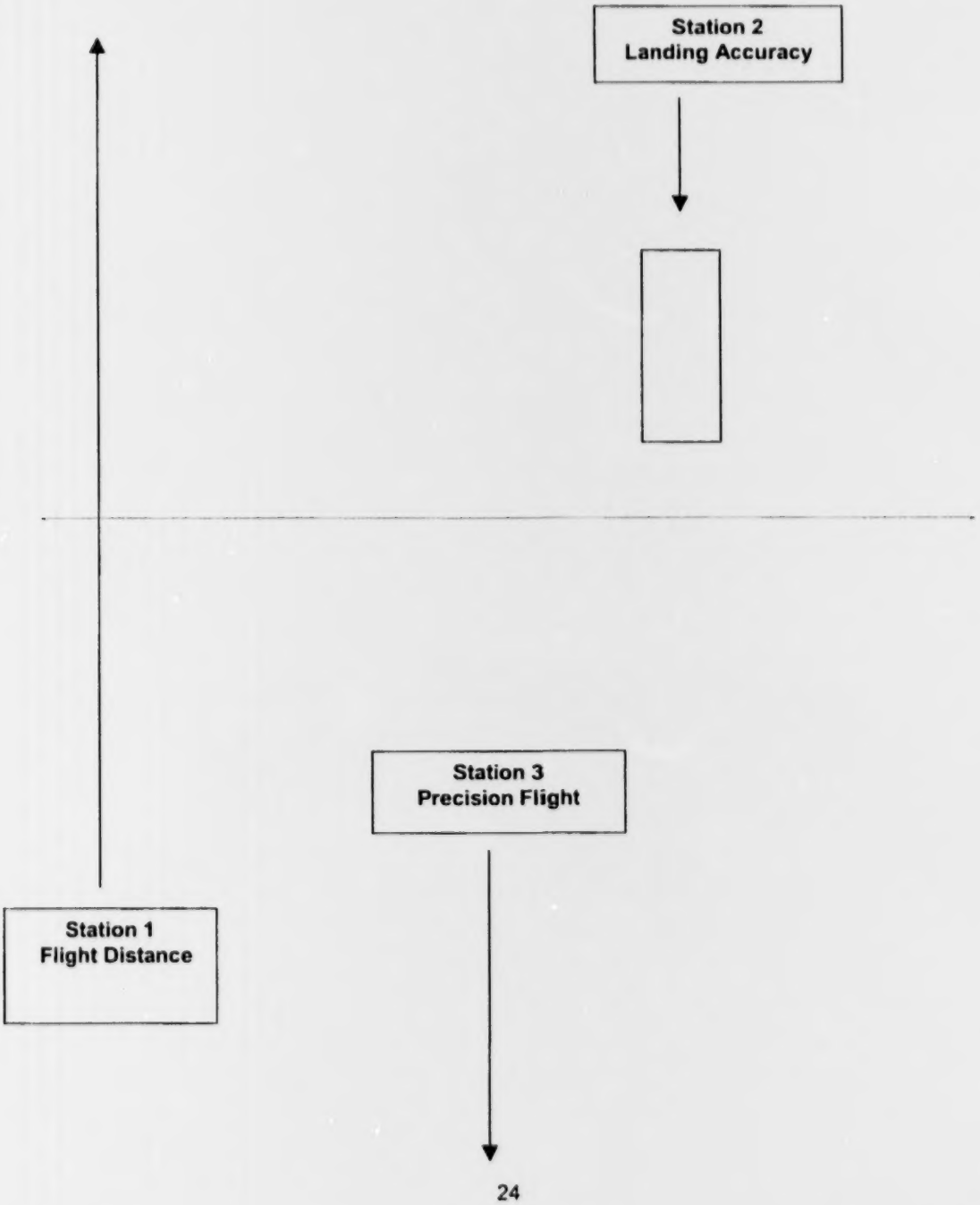
    - Install the igniter into the engine (fuel cartridge). Secure the ignitor into the engine with a colored ignitor plug.
    - Insert the engine into the bottom of the body tube. You will have to move the retaining clips to complete this task.
- Make sure that the wires for the ignitor are not touching each other. Follow the directions very carefully since faculty ignitor wiring is the main cause of engine malfunctions.
- Have the team leaders inspect each rocket for correct assembly and fuel cell insertion.

The Launch

- Launch area safety can not be stressed enough; it is possible to be injured in several different ways with the launch activities.
- Review all safety regulations that are contained in the materials from Estes with all participants prior to moving to the launch area.
- Once you have reviewed launch safety information proceed to the outdoors area (athletic field, large parking lot, etc.).
- Have at least two launch towers set up. Designate one leadership team member as the launch site captain.
- Invite participants one at a time to bring their rocket to the tower. Have each family designate one member to enter the launch area.
- The launch site captain will secure the alligator clips on the wire from the ignition panels to the two leads on the ignitor. Only launch site captain will touch the ignition panel at this time.
- Back away from the rocket as far as the wires will allow.
- Have each family designate a member to push the launch button.
- Using the safety features built into the launch panel, the launch captain will indicate to the family member when it is time to press the firing button. You may wish to use a countdown with each of the team members participating.
- Recover the spent rocket; it can be reused.

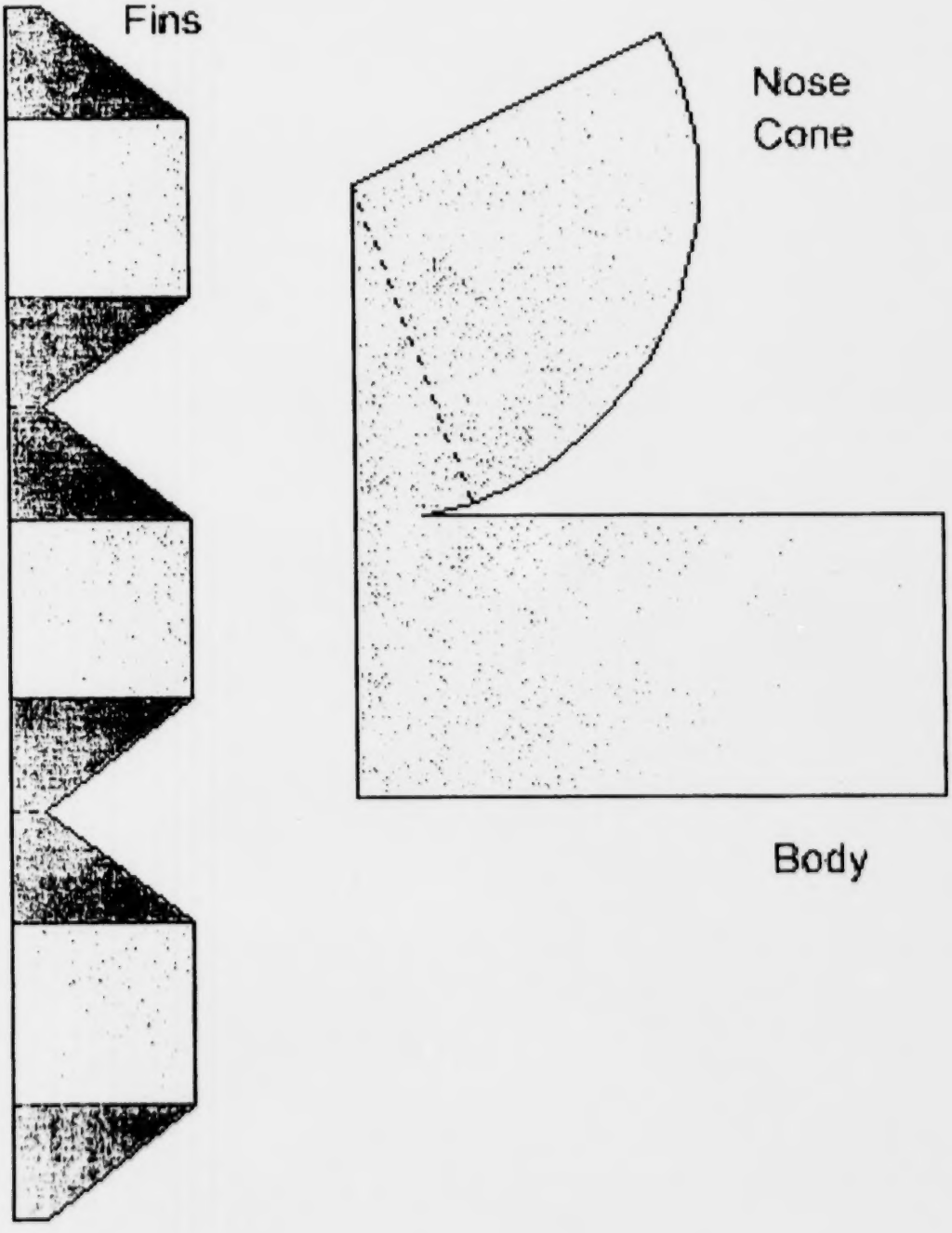
Appendix I

Layout of Family Aeronautical Science First Night Activities
Standard School Gymnasium Location



Appendix II

Seltzer Rocket Pattern



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